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FORM PTO-1390 (REV. 11-2000)

US DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: **P/63011-PCT**

U S. APPLICATION NO. (If known, see 37 CFR 1 5): 10/069196

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/IB00/01179	**August 15, 2000**	**August 21, 1999**

TITLE OF INVENTION **METHOD FOR REGULATING A FREQUENCY OFFSET IN A BASE-STATION RECEIVER OF A DATA COMMUNICATIONS SYSTEM**

APPLICANT(S) FOR DO/EO/US **Wolfgang BODENSCHATZ**

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [X] This is an express request to begin national examination procedures (35 U.S.C. 371 (f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [ ] The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   - a. [ ] is attached hereto (required only if not communicated by the International Bureau).
   - b. [X] has been communicated by the International Bureau.
   - c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [ ] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   - a. [ ] is attached hereto.
   - b. [ ] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [X] Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3)).
   - a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   - b. [ ] have been communicated by the International Bureau.
   - c. [X] have not been made; however, the time limit for making such amendments has NOT expired.
   - d. [ ] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).
9. [ ] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [ ] An English language translation of the annexes to the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. [ ] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [ ] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [ ] A substitute specification.
16. [ ] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.
18. [ ] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).
20. [X] Other items or information: **Receipt Acknowledgment Postcard**

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U.S. APPLICATION NO (if known, see 37 CFR 1.5) 10/069196	INTERNATIONAL APPLICATION NO PCT/IB00/01179	ATTORNEY'S DOCKET NUMBER P/63011-PCT

21. [X] The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)) :

		CALCULATIONS PTO USE ONLY
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO	$1,040.00	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO	$890.00	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO	$740.00	
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4)	$710.00	
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4)	$100.00	

ENTER APPROPRIATE BASIC FEE AMOUNT =				$890.00	
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492 (e)).				$0.00	
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	$	
Total claims	5 - 20 =	0	x **$18.00**	$0.00	
Independent claims	1 - 3 =	0	x **$84.00**	$0.00	
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$280.00**	$0.00	
TOTAL OF ABOVE CALCULATIONS =				$890.00	
[ ] Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.				$0.00	
SUBTOTAL =				$890.00	
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$0.00	
TOTAL NATIONAL FEE =				$890.00	
Fee for recording the enclosed assignment (37 CFR 1.21 (h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$0.00	
TOTAL FEES ENCLOSED =				$890.00	
				Amount to be refunded:	$
				charged:	$

a. [X] A check in the amount of **$890.00** to cover the above fees is enclosed.

b. [ ] Please charge my Deposit Account No. ________________ in the amount of $__________ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 11-1145. A duplicate copy of this sheet is enclosed.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

KIRSCHSTEIN, OTTINGER, ISRAEL & SCHIFFMILLER, P.C.
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SIGNATURE:

Alan Israel
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27,564
REGISTRATION NUMBER

I hereby certify that this correspondence is being deposited with the U.S. Postal Service as Express Mail No. EL 337 912 065 US in an envelope addressed to: Box: PCT, Commissioner of Patents and Trademarks, Washington, D.C., 20231, on:
February 12, 2002
(date) *Alan Israel* *Reg. No. 27,564*

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#4

Docket No.: P/63011

PATENTS

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

I hereby certify that this correspondence is being deposited with the U.S Postal Service as Express Mail No EL 337 912 485 US in an envelope addressed to: Box: PCT, Commissioner of Patents and Trademarks, Washington, D C , 20231, on:
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Alan Israel
Reg No 27,564

International Application No.:		PCT/IB00/01179
International Filing Date	:	August 15, 2000
In re: Application of	:	Wolfgang BODENSCHATZ
Serial No.	:	10/069,196
Deposited	:	February 12, 2002
For	:	METHOD FOR REGULATING A FREQUENCY OFFSET IN A BASE-STATION RECEIVER OF A DATA COMMUNICATIONS SYSTEM

New York, New York
July 2, 2002

PRELIMINARY AMENDMENT

BOX: PCT
Commissioner of Patents and Trademarks
Washington, D.C. 20231

Sir:

Prior to calculation of the filing fee and before examination, kindly amend the above captioned application as follows:

IN THE CLAIMS:

Please cancel claims 1-5, without prejudice.

Please add the new set of claims 6-10 set forth on the enclosed pages.

IN THE ABSTRACT:

Delete the "Abstract"on the PCT cover sheet and replace it with the "Abstract of the Disclosure" set forth on a separate sheet attached hereto.

REMARKS

An abstract has been provided on a separate sheet; and the claims have been amended to conform to U.S. practice.

Accompanying this communication is a literal English translation of the above identified application, and the fee of $130.00 as set forth under 37 C.F.R. §1.492(f). The undersigned attorney asks that the English translation be used as the copy for examination purposes as required under 37 C.F.R. §1.52.

If there are any additional charges, or any overpayment, in connection with the filing of this Communication, the Commissioner is hereby authorized to charge any such deficiency, or credit any such overpayment, to Deposit Account No. 11-1145.

Wherefore, an early action on the merits is earnestly solicited.

Respectfully submitted,

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ABSTRACT OF THE DISCLOSURE

A method which significantly reduces a frequency offset in a base-station receiver, with the minimum effort possible, sets a reference frequency of a demodulator in each subscriber station in such a way, that its output signal no longer has a carrier frequency portion. A reference frequency for a modulator is calculated and set using the reference frequency, set in the above manner for the demodulator of the relevant subscriber station, and using all the given predetermined converter reference frequencies in the subscriber station and in the base station, on condition that a carrier frequency which occurs in the output signal of the base-station demodulator is set to zero.

NEW CLAIMS

6. A method of correcting a frequency offset in a receiver of a base station of a data transmission system in which the base station sends data in time multiplex to several subscriber stations, and in which data transfer occurs from the subscriber stations to the base station in time multiplex with multiple access, comprising the steps of:

a) setting, in each subscriber station, a reference frequency of a demodulator so that its output signal has no carrier frequency portion,

b) calculating a reference frequency for a modulator in the subscriber station from the reference frequency set for the demodulator in the corresponding subscriber station and from all converter reference frequencies stipulated in the subscriber station and in the base station under a condition that a carrier frequency, representing the frequency offset occurring in an output signal of the modulator of the base station, is set to zero, and

c) setting the reference frequency for the modulator of the subscriber station at a calculated value of the reference frequency for the modulator.

7. The method according to claim 6, wherein the calculating step is performed by calculating the reference frequency for the modulator of the subscriber station from a condition that a sum of the reference frequencies for the modulators, demodulators, and intermediate frequency converters in the base station and in the subscriber station is set at zero, the reference frequencies in both the base station and the subscriber station for the radio frequency converters being equal in receiving and transmitting branches, but of opposite phase.

8. The method according to claim 6, wherein the reference frequencies in the base station and in each subscriber station for frequency conversion in the modulators, demodulators,

and for one or more intermediate frequency converters are formed by a first local oscillator by multiplying a first local oscillator frequency by corresponding conversion factors, and wherein the reference frequencies for radio frequency converters are generated by a second local oscillator by multiplying a second local oscillator frequency by corresponding conversion factors.

9. The method according to claim 8, wherein the conversion factor for the modulator of the subscriber station is calculated from a condition that a sum of a first product, formed by multiplying the first local oscillator frequency of the base station by a sum of the conversion factors for the modulator and the demodulator and of the intermediate frequency conversion factors in the receiving and transmitting branch, and a second product, formed by multiplying the first local oscillator frequency of the subscriber station by a sum of the conversion factors for the modulator and the demodulator and of the intermediate frequency conversion factors in the receiving and transmitting branch, are set at zero, and wherein the conversion factors for the radio frequency converters in the receiving and transmitting branches both in the base station and in the subscriber station are equal in size, but of opposite sign.

10. The method according to claim 9, wherein the first local oscillator frequency of the base station is derived in the subscriber station from a symbol rate of data transmitted from the base station to the subscriber station.

WO 01/15315 **PCT/IBOO/01179**

Method for Correcting Frequency Offset in the Receiver of a Base Station of a Data Transmission System

Prior art

The present invention concerns a method for correcting frequency offset in the receiver of a base station of a data transmission system, in which the base station transmits data in time multiplex to several subscriber stations, and data transmission from subscribers to the base station occurs in time multiplex with multiple access.

A point-to-multipoint radio transmission system is known from DE 196 35 533 A1 in which data transmission occurs between a base station and several subscriber stations in time multiplex (TDM/TDMA). The base station and subscriber stations are essentially designed the same and have in their transmission branch a modulator, one or more intermediate frequency (IF) stages and a high frequency (HF) stage, and similarly in their receiving branch an RF stage, one or more HF stages, and a demodulator. The IF and RF stages, and the modulator and demodulator each have a converter controlled by a reference frequency. The reference frequencies are made available by local oscillators in corresponding frequency positions.

In the mentioned TDM/TDMA data transmission system the base station delivers messages to a number of subscriber stations in the form of a continuous data stream multiplexed with reference to time. Each of the existing subscriber stations sends its data to the base station in a time slot allocated to it individually. From the viewpoint of the base station, data bursts therefore arrive from different subscriber stations according to a stipulated schedule. The individual incoming data bursts must be demodulated as free of error as possible at the base station. To do this, it is essential that the receiver of the base station be locked onto the carrier frequency of the incoming data bursts with the greatest possible accuracy. A prerequisite for this is that a frequency offset between the data bursts received by the base station and the frequency normal of the base station be as limited as possible, ideally zero.

The underlying task of the invention is therefore to offer a method of the type just mentioned by which a frequency offset can be corrected in the receiver of a base station with the least possible demands.

Advantages of the invention

The mentioned task is solved with the features of Claim 1, in that the reference frequency of the demodulator of each subscriber station is initially set so that its output signal has no carrier frequency fraction. A reference frequency for the modulator in the subscriber station is then calculated from the reference frequency so set for the demodulator in the corresponding subscriber station and at all fixed converter reference frequencies in the base station under the condition that a carrier frequency occurring in the output signal of the demodulator of the base station and representing a frequency offset is set at zero. The reference frequency for the demodulator of the subscriber station is finally set at the calculated value.

In order to control an existing frequency offset in the receiver of the base station, the reference frequency for the modulator need only be set in the individual subscriber station at a value that can be numerically calculated in simple fashion from known quantities.

Advantageous modifications of the invention are apparent from the subclaims.

The reference frequency for the modulator of the subscriber station is therefore calculated from the condition that the sum of the reference frequencies for the modulators, demodulators and intermediate frequency converters in the base station and in the subscriber station is set at zero, the reference frequencies for the RF converter in the receiving and sending branch being the same but of opposite phase both in the base station and in the subscriber station.

The reference frequencies in the base station and in each subscriber station for frequency conversion in the modulator and demodulator and for one or more intermediate frequency converters are preferably formed by a local oscillator by multiplying the local oscillator frequency by corresponding conversion factors, and reference frequencies for the RF converters are generated by an additional local oscillator by multiplying a local oscillator frequency by corresponding conversion factors.

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To control a frequency offset, the conversion factor for the modulator of the corresponding subscriber station is calculated from the condition that the sum of a first product, formed by multiplying the local oscillator frequency of the base station by the sum of the conversion factors for the modulator and demodulator and the intermediate frequency conversion factors in the receiving and sending branch, and a second product, formed by multiplying the local oscillator frequency of the subscriber station by the sum of the conversion factors for the modulator and demodulator and the intermediate frequency conversion factors in the receiving and transmitting branch, is set at zero. As a further condition, it must be stipulated that the conversion factors for the RF converters in the receiving and transmitting branch in both the base station and subscriber station be equally large but of opposite sign.

The local oscillator frequency of the base station is preferably derived in the subscriber station from the symbol rate of the data transmitted from the base station to the subscriber station.

Drawings

The invention is further explained below with reference to a practical example depicted in the drawing. In the drawing:

Figure 1 shows a schematic of a base station and

Figure 2 shows a schematic of a subscriber station.

Description of a practical example

A transmitting/receiving circuit of a base station of a point-to-multipoint radio system is shown in Figure 1. Data transmission occurs between this base station and several subscriber stations, the base station transmitting a continuous time-multiplexed (TDM) data stream to the subscriber stations, which access the data bursts in the time slots of the data stream allocated to them in time multiplex with multiple access (TDMA). The individual subscriber stations also send their data in the direction of the base station according to the TDMA principle in fixed time slots. A transmitting/receiving antenna AB belonging to the base station is shown in Figure 1. It can transmit data in several solid sectors in which the subscriber stations are located, or receive signals from these several sectors from the subscriber stations. Each subscriber station, one of which is shown as an

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example in Figure 2, has an antenna AC, which is aligned on the base station and can receive signals from it or send signals to it.

Since the invention involves the correction of a frequency offset, only the circuitry generating and converting all the carrier frequencies is shown in the base station and subscriber station depicted in Figures 1 and 2. Other circuits required for signal processing have been omitted from the depiction.

In the transmitting branch of the base station (Figure 1), modulation signal x is modulated by converter UBM of a modulator onto a carrier that corresponds to a frequency of a first free-running local oscillator LO1 multiplied by conversion factor a. Frequency fBMT originating from converter UBM is fed to first intermediate frequency converter UBZ1T. As reference frequency, this converter UBZ1T receives the frequency of the first local oscillator LO1 multiplied by conversion factor b. The output carrier frequency fBI1T of first IF converter UBZ1T reaches the second IF converter UBZ2T. This second IF converter UBZ2T is controlled by the frequency of first local oscillator LO1 multiplied by conversion factor c. In a data transmission system only a single stage, or more than two intermediate frequency stages, can also be present, deviating from the depicted practical examples.

Output carrier frequency fBI2T of the second IF converter UBZ2T reaches the input of an RF converter UBRT. The reference frequency for this RF converter is the frequency of second free-running local oscillator LO2 multiplied by conversion factor d. The transmitting frequency fBRT is available at the output of RF converter UBRT.

In the receiving branch, RF converter UBRR is present, to which receiving frequency fBRR is fed. The reference frequency for this RF converter is again the frequency generated by a second local oscillator LO2 multiplied by conversion factor d'. Output carrier frequency fBI2R of RF converter UBRR lies at the input of IF converter UBZ2R. IF converter UBZ2R is controlled by the frequency of first local oscillator LO1 multiplied by conversion factor c'. As in the transmitting branch, additional IF converter UBZ1R is also present in the receiving branch. This converter UBZ1R converts carrier frequency fBI1R, delivered from the preceding IF converter UBZ2R by means of a frequency originating from the first local oscillator LO1 and multiplied by conversion factor b', to an intermediate frequency fBMR. This is followed by converter UBD of a demodulator

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that demodulates the received signal reduced to the intermediate frequency level. As reference frequency, converter UBD receives the frequency generated from local oscillator LO1 multiplied by conversion factor a'. The demodulated base band signal x' is available at the output of the converter UBD.

In the subscriber station depicted in Figure 2, a modulator is situated in the transmitting branch with converter UCM that modulates modulation signal y' onto a carrier. For this purpose converter UCM of the modulator receives a reference frequency that corresponds to a frequency of first free-running local oscillator LO4 multiplied by conversion factor h'. Carrier frequency fCMT originating from converter UCM is fed to first intermediate frequency converter UCZ1T. This IF converter UCZ1T receives as reference frequency the frequency of first local oscillator LO4 multiplied by conversion factor g'. Output frequency fCI1T of first IF converter UCZ1T reaches second IF converter UCZ2T. This converter UCZ2T is controlled by the frequency of first local oscillator LO4 multiplied by conversion factor f'. As already explained in conjunction with the base station, deviating from the depicted practical example, the subscriber station can also be provided with only one intermediate frequency stage or there can also be more than two.

Output frequency fCI2T of second IF converter UCZ2T reaches the input of RF converter UCRT. The reference frequency for this RF converter is the frequency of second free-running local oscillator LO3 multiplied by conversion factor e'. The transmitting carrier frequency fCRT is available at the output of RF converter UCRT.

RF converter UCRR, to which receiving carrier frequency fCRR is fed, is present in the receiving branch of the subscriber station. The reference frequency for this RF converter is again the frequency generated by second local oscillator LO3 multiplied by conversion factor e. Output carrier frequency fCI2R of RF converter UCRR lies at the input of IF converter UCZ2R. This converter UCZ2R is controlled by the frequency of first local oscillator LO4 multiplied by conversion factor f. As in the transmitting branch, an additional IF converter UCZ1R is also present in the receiving branch. This converter UCZ1R converts carrier frequency fCI1R, delivered from preceding IF converter UCZ2R by means of the frequency originating from first local oscillator LO4 multiplied by conversion factor g, to intermediate carrier frequency fCMR. A demodulator follows with converter UCD that demodulates the received signal reduced to the intermediate frequency level. As

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reference frequency, converter UCD receives the frequency generated by first local oscillator LO4 multiplied by conversion factor h. Demodulated received signal y is available at the output of converter UCD.

If the downlink is considered, i.e., data transmission from the base station to the subscriber station, output frequency y according to equation (1) is obtained from input frequency x of the transmitting branch of the base station and the reference frequencies for converters UBM, UBZ1T, UBZ2T, UBRT and the reference frequencies for the converters UCRR, UCZ2R, UCZ1R and UCD of the receiving branch of the subscriber station.

$$x + LO1\cdot a + LO1\cdot b + LO1\cdot c + LO2\cdot d + LO3\cdot e + LO4\cdot f + LO4\cdot g + LO4\cdot h = y \quad (1)$$

For the uplink, which is the data transmission direction from the subscriber station to the base station, carrier frequency x' is produced at the output of the modulator according to equation (2) from input frequency y' of the transmitting branch of the subscriber station and the reference frequencies for converters UCM, UCZ1T, UCZ2T, UCRT of the transmitting branch of the subscriber station and the reference frequencies for converters UBRR, UBZ2R, UBZ1R and UBD of the receiving branch of the base station.

$$y' + LO4\cdot g' + LO4\cdot g' + LO4\cdot f' + LO3\cdot e' + LO2\cdot d' + LO1\cdot c' + LO1\cdot b' + LO1\cdot a' = x' \quad (2)$$

It follows from equations (1) and (2) that:

$$x' - x = LO1\cdot(a + b + c + a' + b' + c') + LO2\cdot(d + d') + LO3\cdot(e + e') + \\ + LO4\cdot(f + g + h + f' + g' + h') + y' - y \quad (3)$$

Since transmitting frequencies x and y' of the base station and the subscriber station are base band signals and are therefore zero by definition, equation (4) follows from equation (3).

$$x' = LO1\cdot(a + b + c + a' + b' + c') + LO2\cdot(d + d') + LO3\cdot(e + e') + \\ + LO4\cdot(f + g + h + f' + g' + h') - y \quad (4)$$

A frequency offset in the base station is expressed by the fact that output signal x' of demodulator UBD still has a carrier frequency fraction in addition to the base band signal.

The objective is to control the frequencies so that the frequency offset in the form of a carrier frequency fraction appearing at the demodulator output of the base station disappears. This frequency offset is corrected merely by the fact that conversion factors h and h' for demodulator converter UCD

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and modulator converter UCM are variable in the subscriber station and are set at the desired values h'* and h*. The change in conversion factors h and h' occurs by processor PZ. To correct the frequency offset, processor PZ controls conversion factor h for converter UCD of the demodulator to a value h* so that y = 0, i.e., so that a carrier frequency fraction no longer occurs in the output signal of demodulator converter UCD. Under the condition of y = 0, equation (4) can be rewritten into equation (5)

$$x' = LO1\cdot(a + b + c + a' + b' + c') + LO2\cdot(d + d') + LO3\cdot(e + e') + \\ + LO4\cdot(f + g + h + f' + g' + h') - y \qquad (5)$$

In order to correct the frequency offset, the objective is to achieve x' = 0, which means that a carrier frequency fraction is no longer present in the output signal of the demodulator of the base station. In equation (5), x' = 0 when the conditions according to the following equations (6), (7) and (8) are fulfilled. The conditions in equations (6) and (7) state that the conversion factors d, d' and e, e' for the RF converter in the transmitting and receiving branch of the base station and the subscriber station are equally large but must have opposite signs. This means that the reference frequencies for the converters in the transmitting and receiving branches are equal but must have a phase shift of 180°.

$$d = -d' \qquad (6)$$

$$e = -e' \qquad (7)$$

$$LO1\cdot(a + b + c + a' + b' + c') + LO4\cdot(f + g + h^* + f' + g' + h'^*) = 0 \qquad (8)$$

From equation (8), we obtain a new conversion factor h'* to be set by processor PZ for modulator UCM of the subscriber station according to equation (9).

$$h'^* = -(LO1/LO4)\cdot(a + b + c + a' + b' + c') - (f + g + h^* + f' + g') \qquad (9)$$

If equation (9) is fulfilled for conversion factor h'*, the frequency offset is fully eliminated in the base station, i.e., a carrier frequency fraction no longer occurs in addition to the base band signal at the output of demodulator UBD.

Local oscillator frequencies LO1 and LO4 occurring in equation (9) are known from the nominal value, but the actual deviations from the reference value are not known. Under the condition that a symbol rate SRB is sent from the base station, which is derived from the clock rate of local oscillator LO1, the following applies:

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$$SRB = LO1/p \qquad (10)$$

In the base station, a symbol rate SRC according to equation (11) is then received, which depends on the time basis of the local oscillator LO4.

$$SRC = LO4/q \qquad (11)$$

Since the symbol rate is not determined by an additional local oscillator,

$$SRB = SRC \qquad (12)$$

The following applies for factors p and q in equations (10), (11) and (12).

$$p/q = LO1/LO4 \qquad (13)$$

Factor p is a defined value in the base station that is known to processor PZ in the subscriber station. Processor PZ determines factor q by deriving the symbol rate SRC from the received signal y and relating it according to equation (11) to the known system clock frequency of the local oscillator LO4.

For equation (13), we finally obtain, from equation (9), equation (14), according to which processor PZ calculates the conversion factor h'* to be set. The conversion factors a, b, c, a', b', c', f, g, f', g' occurring in equation (14) are fixed values and are known to processor PZ, which has also determined beforehand the new conversion factor h* for the demodulator.

$$h'^* = -(p/q)\cdot(a + b + c + a' + b' + c') - (f + g + h^* + f' + g') \qquad (14)$$

The frequency synchronization discussed above is conducted between each of the subscriber stations and base stations.

An advantage of the described correction of a frequency offset in the base station consists of the fact that the local oscillators can be free-running. Flexible layout of the conversion factors is also possible so that considerable latitude is obtained for the choice of duplex frequency spacings.

Claims

1. Method for correcting a frequency offset in the receiver of a base station of an data transmission system in which the base station sends data in time multiplex to several subscriber stations and data transfer occurs from the subscribers to the base station in time multiplex with multiple access, characterized by the fact:

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- that in each subscriber station the reference frequency of its demodulator (UCD) is set so that its output signal (y) has no carrier frequency fraction,

- that a reference frequency for the modulator (UCM) in the subscriber station is calculated from the reference frequency so set for the demodulator (UCD) in the corresponding subscriber station and from all converter reference frequencies stipulated in the subscriber station and in the base station under the condition that a carrier frequency, representing a frequency offset occurring in the output signal (x') of the demodulator (UBD) of the base station, is set to zero,

- and that the reference frequency for the modulator (UCM) of the subscriber station is set at the calculated value.

2. Method according to Claim 1, characterized by the fact that the reference frequency for the modulator (UCM) of the subscriber station is calculated from the condition that the sum of the reference frequencies for the modulators (UBM, UCM), demodulators (UBD, UCD) and intermediate frequency converters (UBZ1T, UBZ2T, UBZ1R, UBZ2R, UCZ1T, UCZ2T, UCZ1R, UCZ2R) in the base station and in the subscriber station is set at zero, the reference frequencies in both the base station and subscriber station for the RF converters (UBRT, UBRR, UCRT, UCRR) being equal in the receiving and transmitting branches, but of opposite phase.

3. Method according to Claim 1, characterized by the fact that the reference frequencies in the base station and in each subscriber station for frequency conversion in the modulators (UBM, UCM) and demodulators (UBD, UCD) and for one or more intermediate frequency converters (UBZ1T, UBZ2T, UBZ1R, UBZ2R, UCZ1T, UCZ2T, UCZ1R, UCZ2R) are formed by a local oscillator (LO1, LO4) by multiplying the local oscillator frequency by corresponding conversion factors (a, b, c, a', b', c', e, f, g, e', f', g'), and that the reference frequencies for the RF converters (UBRT, UBRR, UCRT, UCRR) are generated by a second local oscillator (LO2, LO3) by multiplying the local oscillator frequency by corresponding conversion factors (d, d', e, e').

4. Method according to Claim 3, characterized by the fact that the conversion factor (h'*) for the modulator (UCM) of the subscriber station is calculated from the condition that the sum of a first product, formed by multiplying the local oscillator frequency (LO1) of the base station by the sum of the conversion factors (a, a') for the modulator (UBM) and the demodulator (UBD) and the intermediate frequency conversion factors (b, c, b', c') in the receiving and transmitting branch,

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and a second product, formed by multiplying the local oscillator frequency (LO4) of the subscriber station by the sum of the conversion factors (h', h) for modulator (UCM) and demodulator (UCD) and the intermediate frequency conversion factors (f, g, f', g') in the receiving and transmitting branch, are set at zero, with the conversion factors (d, d', e, e') for the RF converters (UBRT, UBRR, UCRR, UCRT) in the receiving and transmitting branches both in the base station and in the subscriber station being equal in size but of opposite sign.

5. Method according to Claim 4, characterized by the fact that the local oscillator frequency (LO1) of the base station is derived in the subscriber station from the symbol rate of data transmitted from the base station to the subscriber station.

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(12) NACH DEM VERTRAG ÜBER DIE INTERNATIONALE ZUSAMMENARBEIT AUF DEM GEBIET DES PATENTWESENS (PCT) VERÖFFENTLICHTE INTERNATIONALE ANMELDUNG

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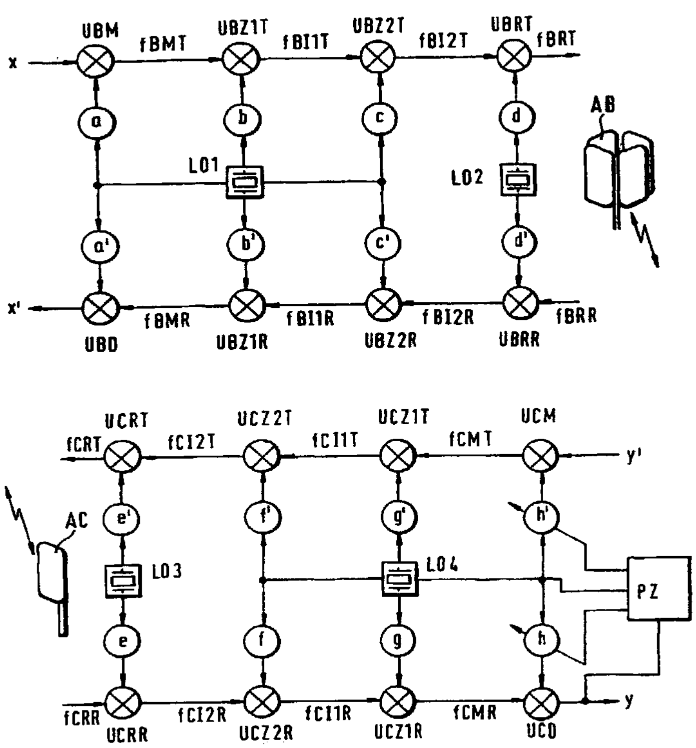
[Fortsetzung auf der nächsten Seite]

(54) **Title:** METHOD FOR REGULATING A FREQUENCY OFFSET IN A BASE-STATION RECEIVER OF A DATA COMMUNICATIONS SYSTEM

(54) **Bezeichnung:** VERFAHREN ZUM AUSREGELN EINES FREQUENZOFFSETS IM EMPFÄNGER EINER BASISSTATION EINES NACHRICHTENÜBERTRAGUNGSSYSTEMS



(57) **Abstract:** The invention aims to provide a method which significantly reduces a frequency offset in the base-station receiver, with the minimum effort possible. To this end, the reference frequency of the demodulator (UCD) in each subscriber station is set in such a way, that its output signal (y) no longer has a carrier frequency portion. A reference frequency for the modulator (UCM) is calculated and set using the reference frequency, set in the above manner for the demodulator (UCD) of the relevant subscriber station and using all the given predetermined converter reference frequencies in said subscriber station and in the base station, on condition that a carrier frequency which occurs in the output signal (x') of the base-station demodulator (UBD) is set to zero.

(57) **Zusammenfassung:** Es soll ein Verfahren angegeben werden, das mit möglichst geringem Aufwand eine weitgehende Reduzierung eines Frequenzoffsets im Empfänger der Basisstation durchführt. Dazu wird in jeder Teilnehmerstation die Referenzfrequenz ihres Demodulators (UCD) so eingestellt, daß dessen Ausgangssignal (y) keinen Trägerfrequenzanteil mehr aufweist. Aus der so eingestellten Referenzfrequenz für den Demodulator (UCD)

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DECLARATION FOR UTILITY OR DESIGN PATENT APPLICATION

☐ Declaration Submitted with Initial Filing OR ☒ Declaration Submitted after Initial Filing

Attorney Docket Number	P/63011
First Named Inventor	BODENSCHATZ, WOLFGANG
COMPLETE IF KNOWN	
Application Number	10/069,196
Filing Date	February 12, 2002
Group Art Unit	
Examiner Name	

As a below named inventor, I hereby declare that:

My residence, post office address, and citizenship are as stated below next to my name.

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

METHOD FOR REGULATING A FREQUENCY OFFSET IN A BASE-STATION RECEIVER OF A DATA COMMUNICATIONS SYSTEM

(Title of the Invention)

the specification of which

☐ is attached hereto

OR

☒ was filed on (MM/DD/YYYY) February 12, 2002 as United States Application Number or PCT International

Application Number 10/069,196 and was amended on (MM/DD/YYYY) ______ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment specifically referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37 Code of Federal Regulations, §1.56.

I hereby claim foreign priority benefits under Title 35, United States Code §119 (a)-(d) or §365(b) of any foreign application(s) for patent or inventor's certificate, or §365 (a) of any PCT international application which designated at least one country other than the United States of America, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or of any PCT international application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application Number(s)	Country	Foreign Filing Date (MM/DD/YYYY)	Priority Not Claimed	Certified Copy Attached? YES	NO
19939811.9	Germany	August 21 1999	☐	☐	☒
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐
			☐	☐	☐
PCT/IB00/01179	INTERNATIONAL	August 15, 2000	☐	☐	☒

☐ Additional foreign application numbers are listed on a supplemental priority sheet attached hereto:

I hereby claim the benefit under Title 35, United States Code § 119(e) of any United States provisional application(s) listed below.

Application Number(s)	Filing Date (MM/DD/YYYY)	
		☐ Additional provisional application numbers are listed on a supplemental priority sheet attached hereto.

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DECLARATION

Page 2

I hereby claim the benefit under Title 35, United States Code §120 of any United States application(s), or §365(c) of any PCT international application designating the United States of America, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code §112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

U.S. Parent Application Number	PCT Parent Number	Parent Filing Date (MM/DD/YYYY)	Parent Patent Number *(if applicable)*

☐ Additional U.S. or PCT international application numbers are listed on a supplemental priority sheet attached hereto.

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OR
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Name of Sole or First Inventor: ☐ A petition has been filed for this unsigned inventor

1-00

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☐ Additional inventors are being named on supplemental sheet(s) attached hereto